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U.S. DEPARTMENT OF AGRICULTURE



FARMERS' BULLETIN

578



Contribution from the Bureau of Animal Industry, A. D. Melvin, Chief.

May 18, 1914.

THE MAKING AND FEEDING OF SILAGE.

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MAKING AND FEEDING SILAGE.

By T. E. WOODWARD, of the *Dairy Division*.

SOME POINTS IN FAVOR OF SILAGE.

Within the last 30 years silage has come into general use throughout the United States, especially in those regions where the dairy industry has reached its greatest development. Silage is universally recognized as a good and cheap feed for farm stock, and particularly so for cattle and sheep. There are several reasons for the popularity of silage.

1. Silage is the best and cheapest form in which a succulent feed can be provided for winter use.
2. An acre of corn can be placed in the silo at a cost not exceeding that of shocking, husking, grinding, and shredding.
3. Crops can be put into the silo during weather that could not be utilized in making hay or curing fodder; in some localities this is an important consideration.
4. A given amount of corn in the form of silage will produce more milk than the same amount when shocked and dried.
5. There is less waste in feeding silage than in feeding fodder. Good silage properly fed is all consumed.
6. Silage is very palatable.
7. Silage, like other succulent feeds, has a beneficial effect upon the digestive organs.
8. More stock can be kept on a given area of land when silage is the basis of the ration.

NOTE.—Gives methods and costs of growing and harvesting silage, feeding value, and instructions for filling the silo. Adapted for general circulation. Supersedes Farmers' Bulletin 556.

9. On account of the smaller cost for labor, silage can be used for supplementing pastures more economically than can soiling crops, unless only a small amount of supplementary feed is required.

10. Converting the corn crop into silage clears the land and leaves it ready for another crop sooner than if the corn is shocked and husked.

Because of these advantages of silage it is the general opinion among dairy farmers who have built silos that the use of silage has increased milk production per cow and has increased the profits per acre, though it is no doubt true that in certain localities which are well adapted to the growth of alfalfa or other hays of good quality, the same amount of food nutrients may be produced at less cost in the form of hay than as silage.

SILAGE CROPS.

Almost any green crop can be successfully made into silage if sufficient care is taken to force out the air from the material. On account of the difficulty, however, of expelling air from plants with a hollow stem, such as timothy, oats, and barley, these crops are rarely put into the silo.

CORN.

In all parts of the United States where the silo has come into general use the principal silage crop is corn. One reason for this is that ordinarily corn will produce more food material to the acre than any other crop which can be grown. It is more easily harvested and put into the silo than any of the hay crops, such as clover, cowpeas, or alfalfa. With the harvesting machinery which we have at the present time these crops are much more difficult to handle after being cut. Furthermore, corn makes an excellent quality of silage. The legumes, such as clover and alfalfa, are liable to rot unless special care is taken to pack the silage thoroughly and force the air out.

The only objection which has been raised concerning corn silage is the fact that it contains insufficient protein fully to meet the requirements of animals to which it may be fed. Some persons have advised mixing clover, cowpeas, or alfalfa with the corn when filling the silo in order to correct this deficiency of protein. Such a procedure is not to be advised, however, if it is possible to cure the clover or other crop into hay, which usually can be done if hay caps are used. Since some dry forage should always be fed with the silage, it is better to use the leguminous hay in this way rather than to convert the crop into silage.

VARIETY TO PLANT.

The best variety of corn to plant is that which will mature and yield the largest amount of grain to the acre, since the grain is the

most valuable part of the corn plant. The variety commonly raised in any particular locality for grain will also be the most satisfactory to grow for silage. As will be seen from the table below, taken from the First Annual Report of the Pennsylvania State College, 63 per cent of the digestible food materials present in the corn plant are found in the ears and 37 per cent in the stover.

Yield of digestible matter in corn.

Constituent.	Yield per acre.		
	Ears.	Stover.	Total crop.
	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
Protein.....	244	83	327
Carbohydrates.....	2,301	1,473	3,774
Fat.....	125	22	147
Total.....	2,670	1,578	4,248



FIG. 1.—A field of good corn.

CULTIVATION AND YIELD.

In some sections it is a common practice to plant the corn a little thicker when raised for silage than for grain. Weeds should be kept out, or they will be cut with the corn and may impair the quality of the silage. The amount of silage that can be obtained from an acre of corn will vary from $\frac{1}{4}$ to 20 tons or more. A 50-bushel per

acre crop of corn will yield about 8 to 12 tons of silage per acre, depending upon the amount of foliage and stalk that accompanies the ear. Southern varieties of corn as a rule carry a larger proportion of the plant in the form of stalk and leaves than do the northern-grown varieties.

TIME TO HARVEST.

Corn should be harvested for the silo at about the same time that it is harvested for fodder—that is, when the grain has become glazed and the lower leaves of the stalk have turned brown. The following table taken from the Eighth Annual Report of the New York Experiment Station will furnish valuable information as to the proper time to cut corn for the silo:

Chemical changes during growth of corn plant.

Yield per acre.	Stage of growth.				
	Tasseled July 30.	Silked Aug. 9.	Milk Aug. 21.	Glazed Sept. 7.	Ripe Sept. 23.
Total yield.....	<i>Pounds.</i> 18,045	<i>Pounds.</i> 25,745	<i>Pounds.</i> 32,600	<i>Pounds.</i> 32,295	<i>Pounds.</i> 28,460
Water.....	16,426	22,666	27,957	25,093	20,542
Dry matter.....	1,619	3,078	4,643	7,202	7,918
Ash.....	138.91	201.30	232.15	302.48	364.23
Albuminoids.....	239.77	436.76	478.69	643.86	677.78
Crude fiber.....	514.19	872.93	1,261.97	1,755.85	1,734.04
Nitrogen-free extract.....	653.91	1,399.26	2,441.29	4,239.82	4,827.60
Fat.....	72.20	167.75	228.90	259.99	314.34

The table shows that there is a steady increase in the amount of dry matter and food ingredients in the corn plant up to the time it is ripe. This indicates very plainly that immature corn is inferior to mature corn, whether fed fresh or as silage.

Silage made from immature corn is not only less nutritious but also more acid than that made from more mature corn. The corn should not be allowed to become thoroughly ripe and dry, however, because the stalk and foliage are rendered more difficult to digest, and, besides, the corn can not be packed into the silo tightly enough to prevent "fire-fanging" without using excessive amounts of water. In case the corn is frozen before it is properly matured for cutting, it should be harvested at once before it has had time to dry out to any great extent. Enough water should be added to replace that lost by evaporation through standing in the field after frosting.

SORGHUMS.

Sorghums, both saccharine and nonsaccharine, are readily made into silage. On account of their superiority to corn as drought-resistant crops they are more dependable and yield more in those

regions of the West where the rainfall is too light or irregular for a good growth of corn. The Kansas station reports in Circular 28 that if the sorghums are harvested at the proper stage of maturity—that is, when the seed has become hard—they will make silage which is less acid and more palatable than silage made from corn. Furthermore, its experiments indicate that there is little difference in the feeding values of these silages. It is all-important that the sorghums be harvested at the proper stage of maturity if the best results are to be secured. A mixture of corn and sorghum has proved satisfactory in some localities where the rainfall was so variable as to make the corn crop uncertain.

CLOVER.

Clover is a successful silage crop yielding a palatable product high in protein. The silage made from clover as from other legumes has an objectionable odor, necessitating particular care in feeding to avoid tainting the milk. It does not pack so well as corn, so great care should be exercised in the tramping of the silage at the time of filling, and the depth of the silo should also receive particular attention. A shallow silo will not prove satisfactory. Clover should be chopped before siloing as a matter of convenience in feeding and also to secure more thorough packing, although it can be placed in the silo without chopping. Clover should be harvested at the same time as for making into hay—that is, when in full bloom and some of the first heads are dead. As stated elsewhere, it is usually inadvisable to make clover into silage if it can be made into hay, as is the case under most conditions. It is better practice to raise corn for silage and use the clover in the form of hay as a supplement to the silage.

COWPEAS, ALFALFA, AND SOY BEANS.

All these crops can be successfully made into silage by exercising the same precautions as with clover. They should be cut at the same time as for haymaking. However, it is ordinarily preferable, as with clover, to make them into hay rather than silage. The fermentations which take place in silage made of legumes cause a greater loss of nutritive material than with corn silage.

Corn husks and pea vines from canning factories, beet pulp and other by-products are also used in certain localities for filling the silo.

HARVESTING THE CROP AND FILLING THE SILO.

HARVESTING THE CORN.

Corn for the silo can be cut either by hand or by machine. Hand cutting is practiced on farms where the amount of corn to be harvested is so small as to make the expense of purchasing a corn har-

vester too great to justify its use. Hand cutting is also resorted to through necessity when the corn is down or lodged in such a manner as to prevent the use of the machine. This method of cutting, however, is slow and laborious and there are probably few localities now where the purchase of a harvester would not be a profitable investment. In case the expense is considered too great to be borne by one farmer, two or more could advantageously purchase a machine together.

In using the harvester it will be found a great advantage to make the bundles rather small. This will take more twine, but the extra expense will be more than offset by the ease of handling the bundles



FIG. 2.—Corn harvester at work.

and in feeding them into the silage cutter. Two or three horses, preferably three, and one man will be required to run the harvester; and they should be able to cut about 6 acres a day. The harvester should not get so far ahead of the haulers that the corn will dry out to any considerable extent. (See fig. 2.)

HAULING TO THE CUTTER.

This is ordinarily done with the common flat hay frames. An objection to their use is that it is necessary to lift the green corn fodder to a considerable height in loading, which is hard work. A

low-wheeled wagon is preferable to a high-wheeled one. A low-down rack quite commonly used in some parts of the United States can be easily made. (See fig. 3.) The following are the directions for making this rack, taken from Farmers' Bulletin 292:

The rack * * * consists of two 4 by 6 inch bed pieces, 18 or 20 feet in length, bolted together at one end to form a V. On top of these timbers is built a rack 6 feet in width. The bottom of this rack is about 8 feet long. The end boards are 4 feet high, built flaring so they do not quite touch the wheels. The apex of the V is suspended below the front axle of an ordinary farm wagon by means of a long kingbolt. The other ends are attached below the hind axle by U-shaped clevises. The materials needed in its construction are 80 board feet of 4 by 6 inch plank, 96 feet of boards 1 by 12 inches, 22 feet of lumber 2 by 4 inches, 1 long kingbolt, 2 stirrup rods, and bolts and nails.

The load should be as large as possible, especially when the haul is for some distance. This is a matter which rarely receives sufficient attention by persons filling silos, and in consequence the expense of filling becomes unnecessarily high.

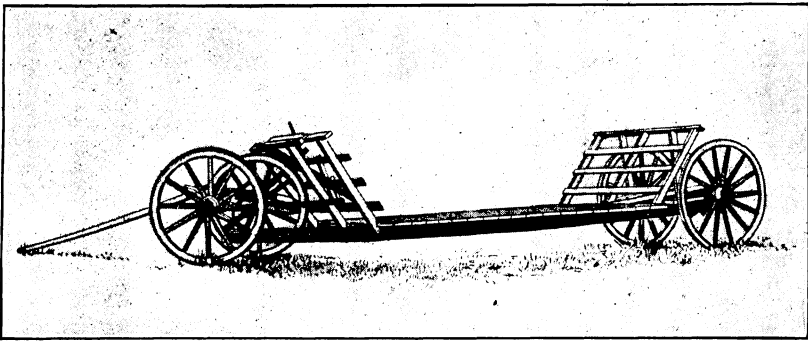


FIG. 3.—A low-down rack suitable for hauling corn to cutter.

CUTTING THE SILAGE.

THE CUTTER.

There are on the market several makes of silage cutters that will give satisfaction. The capacity of the machine to be purchased is an important consideration which should not be overlooked. Many persons make the mistake of getting a cutter which is too small, thus making the operation of filling the silo very slow and interfering with the continuous employment of the entire force of men. It is better to get a machine large enough so that every one will be able to keep busy all the time. The larger cutters are equipped with self-feeders, a labor-saving device which the smaller sizes lack. Other factors to be taken into account in purchasing a cutter are the amount of work to be done and the power available. Of course, for the filling of a very small silo it would not be wise to buy a large machine. Neither would it be advisable to overload the engine or motor by using a cutter which is too large for the power available.

THE ELEVATOR.

Two types of elevators are in use—the old-style chain carrier and the blower. (See fig. 4.) The chain carrier requires less power, but is harder to set up and there is more litter around when it is used, especially in windy weather. For these reasons the blower is now fast displacing the carrier.



FIG. 4.—Silage cutter with chain carrier.

The blower should be placed as nearly perpendicular as possible so as to reduce to the minimum the friction of the cut corn upon the inside of the pipe and lessen the danger of clogging. (See fig. 5.)

POWER REQUIRED.

The power necessary to operate the cutter will depend upon its size and whether the elevator is a chain carrier or a blower and upon the rate of feeding. It is possible to feed slowly and to get along with less power than would be required with full feeding.

As a rule, however, a person should have power sufficient to run the cutter at full capacity, and even a little surplus is advisable. The power required for a cutter and blower, if a gasoline engine is used, is about 1 horsepower for each 1-inch length in the cutting cylinder; that is, a 15-inch cutter will take a 15-horsepower engine, an 18-inch cutter will require an 18-horsepower engine, and so on. If a steam



FIG. 5.—Silage cutter with blower.

engine is employed, the power should be at least two-thirds of that indicated for the gasoline engine.

LENGTH TO CUT.

The usual length of cutting varies from one-half to 1 inch. The latter is considered a little too long, since pieces of this length will neither pack so closely in the silo nor be so completely consumed when fed as will the shorter lengths. On the other hand, the longer the pieces the more rapidly can the corn be run through the cutter.

PACKING THE SILAGE.

Ordinarily the blower or carrier empties the cut corn into the top of the silo and there are one or more men in the silo to distribute and tramp the material. Unless there is some one to do this the cut material will be thrown too much in one place and the leaves, stalks, and grain will not be uniformly distributed throughout the silo. The sides should be kept higher than the center, and the whole surface kept well tramped. Much of the tramping should be done close to the wall.

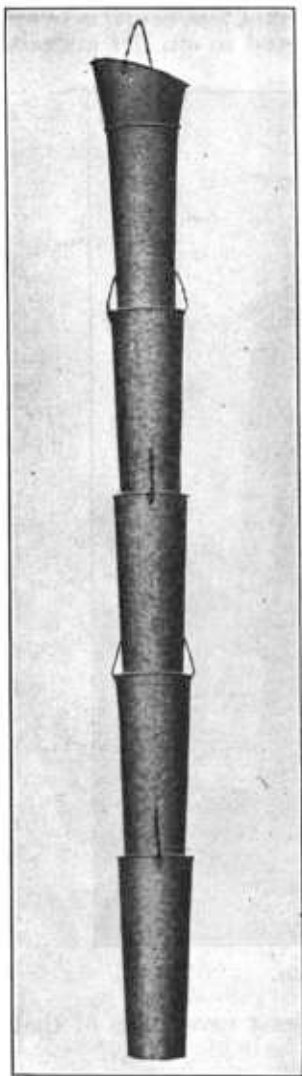


FIG. 6.—Jointed-pipe silage distributor.

Various contrivances have been used for distributing the silage. The one commonly recommended for this purpose, however, is a metal pipe similar to the one in which the cut corn is elevated, but put together loosely in sections. The corn from the blower passes down this pipe into the silo, and being loosely put together it can be swung so that the material can be placed anywhere in the silo. (See fig. 6.) With this contrivance no work with a fork is necessary and one man can do the work of two or three and do it more easily. There is very little loose material flying about in the silo and the work is much cleaner. Another advantage is a lessening of the danger of being struck by some foreign object which might pass up the blower pipe. Heavy knives of the cutter have been known to pass through the blower and into the silo. As has been mentioned, this pipe is put together in sections, so that as the silage rises in the silo the sections can be readily detached as required.

ADDING WATER.

In case the material has become too dry before it is put into the silo, water should be added to supply the deficiency of moisture necessary to make the silage pack properly. Unless it is well packed the silage will "fire-fang" or deteriorate through the growth of mold. Enough water should be added to

restore the moisture content of the corn to what it would be if cut at the proper stage. The water may be added by running directly into the silo by means of a hose or by running through the blower. It is claimed that by running it into the blower the water is more thoroughly mixed with the cut corn.

It seems to be good practice, no matter what the condition of the corn is, to wet down the material thoroughly at the top of the silo when through filling. This will help to pack the top layer and lessen the amount of spoiled silage on top.

COVERING THE SILAGE.

Several years ago it was a common practice to cover the silage with some material, such as dirt or cut straw, in order to prevent the top layer from spoiling. At present when any provision at all is made for this purpose it consists usually in merely running in on top cornstalks from which the ears have been removed. By this method some of the corn grain is saved. The heavy green cornstalks pack much better than straw does and so exclude the air more effectually. The top is thoroughly tramped and then wet down. Sometimes oats are sown on the top before wetting. The heat generated by the fermenting mass will cause the oats to sprout quickly and form a dense sod which serves to shut off the air from the silage beneath, and in consequence only a very shallow layer spoils. Whenever possible, it is better to begin feeding from the silo as soon as it is filled; by doing this no covering is necessary and there should be no loss on account of spoiling.

LABOR AND TEAMS REQUIRED.

The labor and teams to be used will of course depend upon the help available, the length of haul, and the efficiency of the machinery. With plenty of help, a short haul, and good machinery the following distribution of labor might well be used:

- 1 man and 3 horses to bind the corn.
- 3 or 4 men to load the corn.
- 3 men and 6 horses to haul.
- 1 man to help unload.
- 1 man to feed the cutter.
- 1 or 2 men to work in the silo.
- 1 man to tend the engine, if steam engine is used.
- Total, 11 to 13 men, 9 horses, and 3 wagons.

The least amount of help which it would be possible to work to advantage might be arranged as follows:

- 1 man and 2 horses to bind the corn.
- 2 men to help teamsters load.
- 2 men and 4 horses to haul and unload.
- 1 man to feed.
- 1 man in the silo.
- Total, 7 men, 6 horses, and 2 wagons.

A good manager is required to arrange the help so that each man and team can do the most efficient work. Without careful attention to this matter the operation of filling the silo becomes needlessly expensive.

COST OF HARVESTING AND FILLING.

It is not possible to set any definite figure as the cost of filling the silo because of the great variation in conditions in different parts of the country. But in order to give some idea of the probable cost a few figures are taken from Farmers' Bulletin 292. The investigation reported in this bulletin included the work done upon 31 farms in Wisconsin and Michigan. The labor of each man was rated at 15 cents per hour and the same value placed upon each team of two horses. Engine hire was estimated at \$4.50 per day, including the engineer. Twine was rated at 11½ cents a pound, coal at \$5 a ton, and gasoline at 13 cents a gallon. The farmers owned the cutters. In this investigation the cost per ton varied from 46 to 86 cents.

Investigations conducted by the Dairy Division during the past few years with 87 silos in various parts of the United States indicate the cost of filling to be an average of 87 cents per ton. This does not include interest on investment nor depreciation of machinery or silos.

COOPERATION IN SILO FILLING.

The high cost of silo-filling machinery makes it oftentimes advisable for several farmers to cooperate in the purchase of a cutter and engine, or at least a cutter, since an engine is more easily rented than a cutter. By varying the time of planting in the spring each man can get his silo filled when the corn is at the proper stage of maturity. Besides this the farmers can help one another in filling, so that there need be a very small cash outlay.

TOTAL COST OF SILAGE.

As with the cost of filling the silo, no definite figure can be set as to the cost of silage. This will depend upon the yield per acre, the cost of growing an acre, and the cost of filling. Several years ago the cost was variously estimated at from \$1 to \$1.50 per ton. At present this is much too low. The aforesaid data collected by the Dairy Division on the filling of 87 silos in various parts of the country show the cost of growing the silage crop to average \$1.58 per ton. This includes interest on investment in land or rental price, as the case may be, but does not include interest on the cost of equipment nor the depreciation of the equipment. This \$1.58 added to the 87 cents, which represents the cost of filling, makes the total cost of the silage \$2.45 per ton. The cost of the silage for the individual farms varied from \$1.10 to \$5.42 per ton. In general, it

may be stated that \$1.50 to \$4 per ton represents the limits between which most of the silage is produced.

LOSSES OF FOOD MATERIAL IN THE SILO.

When any crop is made into silage certain fermentation takes place, which results in the production of a considerable amount of heat and the consequent loss of food material. The extent of this fermentation is dependent upon the amount of air in the silo. The more air there is present the higher will be the temperature of fermentation and the greater the loss of food ingredients. Fermentation will continue until all the oxygen of the air has been used up or has been displaced by carbon dioxide. In the deep silos of the present time the pressure is so great that very little air is left in the silo; consequently the losses of food ingredients are reduced to a minimum. As before mentioned, on account of the difficulty of pressing out this air in crops with a hollow stem, they are seldom put in the silo.

Some experiments conducted at the Wisconsin station show that the losses in the siloing of corn are not nearly so great as in the field curing of corn fodder. According to Prof. Woll, in modern, well-built, deep silos the loss should not exceed 10 per cent. More food material can be saved by putting the corn crop into the silo than by harvesting and storing it in any other way.

FEEDING VALUE OF SILAGE.

COMPOSITION.

The chemical composition and nutritive value of silage will vary according to the crop from which it is made, the degree of maturity of the crop, and other factors. The figures in the following table, taken from Henry's "Feeds and Feeding," show the average amount of digestible nutrients in 100 pounds of silage and other succulent feeds:

Crop.	Total dry matter.	Digestible dry matter.		
		Protein.	Carbohy- drates.	Fat.
	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
Green fodder corn.....	20.7	1.0	12.2	0.4
Corn silage.....	26.4	1.4	14.2	.7
Green sorghum fodder.....	20.6	1.6	11.6	.3
Sorghum silage.....	23.9	.1	13.5	.2
Uncured red clover.....	29.2	2.9	13.6	.7
Clover silage.....	28.0	1.5	9.2	.5
Uncured soy bean.....	24.9	3.1	11.0	.5
Soy-bean silage.....	25.8	2.7	9.6	1.3
Uncured cowpeas.....	16.4	1.8	8.7	.2
Cowpea vine silage.....	20.7	1.5	8.6	.9
Pasture grass.....	20.0	2.5	10.1	.5
Oats and peas (uncured).....	20.3	1.8	10.2	.4
Mangels.....	9.1	1.0	5.5	.2
Sugar beets.....	13.5	1.3	9.8	.1
Sugar-beet pulp (wet).....	10.2	.5	7.7
Prickly pear.....	15.8	6.2	.2

It will be observed that about three-fourths of the total weight of silage consists of water. It will also be noticed that both corn and sorghum contain a large amount of carbohydrates in proportion to the protein. Silage is a bulky, succulent feed with a wide nutritive ratio, and for these reasons it will give the best results when fed with some other feed richer in dry matter and in protein.

SUCCULENCE.

In feeding cattle it is quite important that the ration include some succulent material, such as fresh grass, root crops, or silage. A feed containing a large amount of water in the form of natural plant juices is not only more easily digested but is also more palatable and, besides, serves the useful purpose of keeping the whole system of the animal in good condition. A silage-fed animal is rarely troubled with constipation or other digestive disturbances, the coat is noticeably sleek and soft, and the skin is soft and pliable. It is a well-known fact that a cow usually reaches her maximum production when she has access to a good pasture. The best and cheapest substitute for fresh pasture grass during the fall and winter is silage.

PALATABILITY.

No rough feed is more palatable than good corn silage. Sometimes, however, a cow will not eat silage readily until she has acquired a taste for it; this may require several days. But silage is not peculiar in this respect, for it has been observed that range horses or cattle shipped into the corn belt refuse corn the first time it is offered to them. The quality of palatability is of great importance, as it induces a large consumption and stimulates the secretion of digestive juices.

SILAGE FOR DAIRY CATTLE.

Silage has been found to be particularly well adapted as a feed for dairy cows and as a consequence silos are more numerous upon farms devoted to dairying than upon any other kind of farms. In many sections silage has come to be the dairy farmer's main reliance for cow feed in winter.

SUPPLEMENTARY FEEDS.

While silage is an excellent feed, it is not a complete one for dairy stock. It is too bulky and watery and contains insufficient protein and mineral matter to meet fully the requirements of the dairy cow. It should be combined with some leguminous hay, such as clover, cowpeas, or alfalfa. These will tend to correct the deficiencies of the silage in dry matter, protein, and mineral constituents. A ration of silage and, say, alfalfa hay alone is satisfactory, however, only for

cows which are dry or giving only a small amount of milk and for heifers and bulls. Cows in full milk require some concentrated feed in addition to hay and silage, as they can not consume enough of these feeds to keep up a large flow of milk and maintain body weight.

AMOUNT TO FEED.

The amount of silage to feed a cow will depend upon the capacity of the animal to consume feed. She should be fed as much as she will clean up without waste when consumed along with her hay and grain. Raise or lower the amount until the proper quantity is ascertained. Generally speaking, a good cow should be fed just short of the limit of her appetite. If she refuses any of her feed it should be reduced at once. The small breeds will eat 25 or 30 pounds per day; the large breeds 40 or more; and the medium-sized ones amounts varying between.

RATIONS.

Ironclad directions for feeding cows can not be given. In general, however, they should be supplied with all the roughage they will clean up with grain in proportion to butterfat produced. The hay will ordinarily range between 5 and 12 pounds per cow per day when fed in connection with silage. For Holsteins 1 pound of concentrates for each 4 pounds of milk produced will prove about right. For Jerseys 1 pound for each 3 pounds of milk or less will come nearer meeting the requirements. The grain for other breeds will vary between these two according to the quality of milk produced. A good rule is to feed seven times as much grain as there is butterfat produced.

The following rations have been found satisfactory:

For a 1,300-pound cow yielding 40 pounds of milk testing 3.5 per cent:

	Pounds.
Silage-----	40
Clover, cowpea, or alfalfa hay-----	10
Grain mixture-----	10

For the same cow yielding 20 pounds of 3.5 per cent milk:

	Pounds.
Silage-----	40
Clover, cowpea, or alfalfa hay-----	5
Grain mixture-----	5

For a 900-pound cow yielding 30 pounds of 5 per cent milk:

	Pounds.
Silage-----	30
Clover, cowpea, or alfalfa hay-----	10
Grain mixture-----	11

For the same cow yielding 15 pounds of 5 per cent milk:

	Pounds.
Silage-----	30
Clover, cowpea, or alfalfa hay-----	8
Grain mixture-----	5

A good grain mixture to be used in a ration which includes silage and some sort of leguminous hay is composed of—

	Parts.
Corn chop-----	4
Wheat bran-----	2
Linseed-oil meal or cottonseed meal-----	1

In case the hay used is not of this kind some of the corn chop may be replaced by linseed or cottonseed meal. In many instances brewers' dried grains or crushed oats may be profitably substituted for the bran, and oftentimes gluten products can be used to advantage in place of bran or oil meals.

TIME TO FEED.

The time to feed silage is directly after milking or at least several hours before milking. If fed immediately before milking the silage odors may pass through the cow's body into the milk. Besides, the milk may receive some taints directly from the stable air. On the other hand, if feeding is done subsequent to milking, the volatile silage odors will have been thrown off before the next milking hour. Silage is usually fed twice a day.

Many objections have been made to the feeding of silage, some condenseries even refusing to let their patrons use it. These objections are becoming less common, since milk from cows fed silage in a proper manner is in no way impaired; furthermore there is nothing about silage that will impair the health of the animals.

FEEDING FROZEN SILAGE.

Frozen silage must be thawed before feeding. If it is then given immediately to the cows before decomposition sets in no harm will result from feeding this kind of silage; neither is the nutritive value known to be changed in any way.

SILAGE FOR CALVES, BULLS, AND DRY COWS.

Calves may be fed silage as soon as they are old enough to eat it. It is perhaps of greater importance that the silage be free from mold or decay when given to calves than when given to mature stock. They may be given at all times all the silage they will eat up clean. Yearling calves will consume about one-half as much as mature stock; that is, from 15 to 20 or more pounds a day. When supplemented with some good leguminous hay, little, if any, grain will be required to keep the calves in a thrifty, growing condition.

There is a decided opinion among some breeders of dairy stock that a large allowance of silage is detrimental to the breeding qualities of the bull. Whether there is any scientific foundation for this opinion remains to be determined. Pending further investigations, however, it is advisable to limit the allowance to about 12 pounds of silage a day for each 1,000 pounds of live weight. When fed in this amount silage is thought to be a good, cheap, and safe feed for bulls. It should of course be supplemented with hay, and with a small allowance of grain also in the case of bulls doing active service or growing rapidly.

Cows when dry will consume almost as much roughage as when they are milked. Silage may well form the principal ingredient of the ration; in fact, with 25 to 40 pounds of silage and a small supplementary feed of clover, cowpea, or alfalfa hay, say 5 to 6 pounds a day, the cows will keep in good flesh and even make some gain. Cows in thin flesh should receive in addition a small amount of grain. Silage will tend to keep the whole system in good condition and in this way lessen the troubles incident to parturition.

SILAGE FOR SUMMER FEEDING.

One of the most trying seasons of the year for the dairy cow is the latter part of summer and early fall. At this season the pastures are often short or dried up, and in such cases it is a common mistake of dairymen to let their cows drop off in flow of milk through lack of feed. Later they find it impossible to restore the milk flow, no matter how the cows are fed. Good dairy practice demands that the milk flow be maintained at a high level all the time from parturition to drying off. It becomes necessary, therefore, to supply some feed to take the place of the grass. The easiest way to do this is by means of silage. Silage is cheaper and decidedly more convenient to use than soiling crops.

The amounts to feed will depend upon the condition of the pastures, varying all the way from 10 pounds to a full winter feed of 40 pounds. It should be remembered in this connection that silage contains a low percentage of protein, so that the greater the amount of silage fed the greater must be the amount of protein in the supplementary feeds to properly balance the ration.

SILAGE FOR HORSES.

By GEORGE M. ROMMEL, *Chief of the Animal Husbandry Division.*

Silage has not been generally fed to horses, partly on account of a certain amount of danger which attends its use for this purpose, but still more, perhaps, on account of prejudice. In many cases horses

have been killed by eating moldy silage, and the careless person who fed it at once blamed the silage itself, rather than his own carelessness and the mold which really was the cause of the trouble. Horses are peculiarly susceptible to the effects of molds, and under certain conditions certain molds grow on silage which are deadly poisons to both horses and mules. Molds must have air to grow and therefore silage which is packed air-tight and fed out rapidly will not become moldy. If the feeder watches the silage carefully as the weather warms up he can soon detect the presence of mold. When mold appears, feeding to horses or mules should stop immediately.

It is also unsafe to feed horses frozen silage on account of the danger of colic. This is practically impossible to avoid in very cold weather, especially in solid-wall silos. By taking the day's feed from the unfrozen center of the silo and chopping away the frozen silage from the edges and piling the frozen pieces in the center the mass will usually thaw out in time for the next feed.

Corn to be made into silage for horses should not be cut too green, as sour silage will result and may cause colic when fed. The corn should be well matured and cut when the grain is beginning to glaze. The silo should be filled rapidly and the corn should be vigorously tramped and packed while filling. At least three men should be inside the silo, moving constantly, two around the edges and the third across and around the center. This is by far the most important point in connection with feeding silage to horses, and the lives of the horses fed on silage may depend on the thoroughness with which the tramping is done. If properly done no danger is likely to result; if not properly done air pockets may form and cause the accumulation of a small mass of mold which the feeder may overlook but which might be sufficient to kill one or more horses.

The value of silage for horses is greatest as a means to carry them through the winter season cheaply or to supplement pasture during drought. As the danger of mold is greater in summer than in winter, silage should not be fed to horses in that season unless a large number of animals are getting it, and the daily consumption is so large as to preclude the formation of mold on the surface.

To cheapen the ration of brood mares in winter no feed has more value than good corn silage. If the grain goes into the silo with the stover no additional grain is needed for brood mares, hay being the only supplementary feed necessary. If there is little grain on the corn the silage should be supplemented with 1 pound of old-process linseed-oil meal or cottonseed meal daily per 1,000 pounds live weight, sprinkled over the silage.

Horses to be wintered on a silage and hay ration should be started on about 5 pounds of silage daily per 1,000 pounds live weight, the

grain and hay ration being gradually decreased as the silage is increased until the ration is 20 pounds silage and 10 pounds of hay daily per 1,000 pounds live weight. It will require about a month to reach the full feed of silage, but the period may be decreased somewhat, depending on the judgment and skill of the feeder.

Mares fed in this manner will be in splendid condition for foaling, and, so far as the writer's experience goes, the foals will be fully as vigorous, with just as much size and bone, as if the mares were fed the conventional grain and hay ration.

Work horses when idle can be wintered satisfactorily in this manner, but much silage is not recommended for horses at heavy work for the same reason that a driving horse can not do his best while on watery grass pasture.

The writer knows of cases where stallions receive a ration of silage, but has had no experience in feeding them in this manner. There seems no reason why silage should not be a valuable feed for stallions during the idle season.

Silage should also be useful for young horses, especially drafters, but here again the writer can not quote his own experience and experimental data are meager.

To summarize, silage is safe to feed to horses and mules only when it is made from fairly mature corn, properly stored in the silo. When it is properly stored and is not allowed to mold, no feed exceeds it as a cheap winter ration. It is most valuable for horses and mules which are not at heavy work, such as brood mares and work horses during the slack season. With plenty of grain on the cornstalks, horses will keep in good condition on a ration of 20 pounds of silage and 10 pounds of hay for each 1,000 pounds of live weight.

SILAGE FOR BEEF CATTLE.

By W. F. WARD, *Animal Husbandman in Beef Cattle Investigations.*

There is no roughage which is of more importance to the producer of beef cattle than silage. The value of silage to the beef producer varies considerably and is dependent upon a large number of other factors. If rough fodders are scarce or are high priced, if the grain is high priced, or if the grain is not near a good market that much of it can be readily sold, silage will have a greater value than if the opposite conditions exist. It is a great saver of grain regardless of whether it is to be fed to stock cattle or fattening cattle. It will lessen the grain feeding by practically the same amount as is contained in the silage. The value will also depend somewhat upon the kind of cattle to which it is to be fed. If there is an abundance of rough fodders which can not be marketed, silage will not be so val-

uable. But in a case of this kind the silage would prove more valuable if used for the calves and pregnant cows and the coarse fodders used for the other stock.

SILAGE FOR THE BREEDING HERD.

For wintering the entire breeding herd there is no roughage better than silage. All of the animals will relish a ration containing it and it will create a good appetite for all other feeds. Cows that are fed all of the silage they will consume along with clover hay will go through the winter in fine shape and make small gains. If the amount of silage is limited, a more economical method of wintering them will be to reduce the silage to a half ration, letting them have the run of a straw stack and feeding about 2 pounds of cottonseed meal or oil meal per day. Some dry coarse fodder or straw should always be kept before animals getting silage, as it reduces the amount of silage consumed and prevents the bowels from becoming too loose. The succulent feed will cause the breeding cows to give a good flow of milk even though the calf be born in midwinter, and a thrifty calf will result. If the silage is free from mold or rotten spots there will be no danger in feeding it to breeding cows.

Silage is especially beneficial for calves which have just been weaned. They take to this ration quicker than to dry feed and there is usually little loss in weight from the weaning. The silage should be supplemented with some good leguminous hay, as alfalfa, cowpea, or clover, and the calves should be given a small amount of grain. A mixture of one-half corn chop and one-half cottonseed meal is excellent.

SILAGE FOR STOCKERS.

Each farmer will have to plan the rations for his cattle according to the amount of the various feeds he has on hand. Stockers can be wintered on silage and some good hay, fodder, or straw, but this may not always be the most profitable. When hay is high priced and grain is reasonably cheap or plenty of silage is available, it may be more economical to omit the hay altogether. A ration of corn silage alone has often been profitable for thin cattle. Stockers which have been fed liberally all winter and made to put on good gains usually do not make as large daily gains when put on grass as do steers which have not been quite so well fed. The time the cattle are to be finished for market and the degree of fatness to be attained should govern to a large extent the method to be followed during the winter. When beeves are expected to sell high in the early summer and the steers are to be finished for market at that time, a heavy roughage ration with a small amount of grain should be fed during the winter months.

SILAGE FOR FATTENING ANIMALS.

Silage stands first in rank of all the roughages for finishing cattle. Formerly, during the era of cheap corn and other concentrates little attention was given to the roughage, as it was usually considered merely a "filler" and of very little economic value in feeding. No especial care was taken in selecting any particular kind, nor was the quality of it seriously considered. As the prices of the concentrated feedstuffs advanced, the feeder looked about for methods of cheapening the cost of producing beef, and soon found this could be accomplished by using judgment in selecting his roughage with respect to the grain fed. This has continued until at the present time the roughage receives as much attention as the concentrated feed, and has been made to take the place of a large amount of the latter. The feeding of silage came into general use with the advent of expensive grain and is becoming more popular each year. With the present prices of feedstuffs there is hardly a ration used for feeding cattle which can not be cheapened by the use of this succulent feed. By combining it with other feeds the efficiency of the ration is increased to such an extent that the amount of the daily gains is invariably greater and the cost of producing a pound of gain is lessened. The heaviest daily gains are usually made during the first stage of the feeding period, and silage can then be used to advantage in large quantities with a small amount of grain, but as the feeding progresses the amount of silage should be lessened and the grain increased. In some places the price of hay and stover is so high that the greater the proportion of silage used in the ration the more profitable is the feeding.

Conditions in general are such that any given ration will not suit a large number of farmers, nor will it be so profitable for some as it will for others, so each farmer must determine for himself just what combination of feeds will be most profitable for his use. However, to give a general idea of some of the rations adapted to different localities and which may prove satisfactory for a 1,000-pound steer, some examples are given below:

RATIONS.

FOR THE CORN BELT.

Ration 1.

	Pounds.
Corn silage	25
Corn stover	6
Cottonseed meal or oil meal	3
Shelled corn	14

Ration 2.

Corn silage	25
Clover hay	7
Shelled corn	15

FOR THE EASTERN STATES WHERE HAY IS VERY HIGH AND CORN IS
RELATIVELY HIGH.

	Pounds.
Corn silage	30
Corn stover	6
Cottonseed meal or oil meal	4
Shelled corn	10

FOR THE SOUTH WHERE COTTONSEED MEAL IS OF MODERATE PRICE AND
COWPEA HAY IS RAISED ON THE FARM.

Ration 1.

	Pounds.
Corn silage	35
Cowpea hay	8
Cottonseed meal or oil meal	7

Ration 2.

Corn silage	30
Cottonseed hulls	12
Cottonseed meal	7

FOR THE WEST WHERE CORN CAN NOT BE RAISED.

Ration 1.

	Pounds.
Kafir-corn silage	30
Prairie hay	3
Cottonseed meal	3
Kafir-corn meal	10

Ration 2.

Kafir-corn silage	25
Alfalfa	7
Kafir corn	15

It should be understood that the above rations are not necessarily to be fed in the exact quantities given above, but should be modified to suit local conditions or the actual conditions on each farm. They are given to show approximately the average amounts and character of feed that would be consumed daily by a 1,000-pound steer during the feeding period.

It is well to feed as near a balanced ration as possible without materially increasing its cost. Sometimes the prices of available feeds are such that a farmer is justified in deviating from the standard. Such conditions are illustrated by the use of some of the rations given above. The second ration shown for the South is an example, as that ration is very narrow, but in certain localities it is more profitable than one which is balanced by the use of high-priced carbohydrate feeds.

Two rations are shown for the West where kafir-corn silage is used. With some farmers it would undoubtedly be more profitable to use alfalfa hay as a substitute for cottonseed meal, while with others the purchase of the cottonseed meal would be more economical.

MISCELLANEOUS CONSIDERATIONS.

Silage is a quick finishing roughage in that it produces large daily gains and produces a glossy coat and a soft, pliable skin. Moreover, it can be used to advantage at times for carrying cattle for a longer time so as to pass over a period of depression in the market, or to carry the cattle along in thrifty condition so they can be finished at a later period.

For many years the belief was general that cattle which received silage as a major portion of the roughage would have to be kept in warm barns and not exposed to the cold. While they do need protection from the cold winds and rains and need a dry place to lie down, it has been clearly demonstrated that warm barns are not only unnecessary, but that fattened cattle make both larger and cheaper gains when fed in the open sheds than when confined in barns. Stocker or thin cattle receiving silage will, of course, need more protection than animals which are being fattened.

Silage can be profitably used to supplement the pastures for steers during a time of drought, when they are being finished for market, but it is still an open question whether it can always be used profitably for feeding to breeding cattle during such times.

The theory that silage-fed cattle shrink very heavily in shipping to market is erroneous. While the actual shrinkage during transit is sometimes greater, the fill taken at market is usually good, and if good judgment is used in preparing them for shipping the net shrinkage is no greater than for cattle which have been fed on dry feeds. For 36 hours previous to shipping nice bright hay and stover should be substituted for the silage in the ration.

The general impression that choice or prime carcasses can not be made by the use of succulent feed is equally untrue, as the silage-fed cattle usually make more desirable carcasses than cattle fed a similar ration, except that silage was replaced by one of the coarse fodders. There is no appreciable difference in the percentage of marketable meat that steers will dress out which have been finished on a silage ration and a dry ration. The meat seems equally bright and the fat as well intermixed with the lean.

If silage makes up the bulk of the roughage it will be necessary to haul large amounts of bedding into the sheds to keep the animals dry, as there is no waste in silage, or else make a cement floor and cover with bedding to absorb the urine and prevent the animals from slipping and to give them a warm place to lie down. When the enormous saving in the quality and amount of the feed is considered, this disadvantage does not seem so hard to overcome by the stockman who has the capital to put up the silo and pave his feed sheds or feed lots.

SILAGE FOR SHEEP.

By E. L. SHAW, *Animal Husbandman in Sheep and Goat Investigations.*

The use of this succulent feed for sheep has attracted the attention of most farmers only during the past few years. Although a few sheepmen fed silage many years ago with good results, most flockmasters have been slow in giving it a trial. Owing to the wonderful increase in the use of silos on farms, and owing to the cheapness of silage as compared with other succulent feeds, such as roots, farmers are constantly raising the question regarding the feeding of silage to sheep. A great deal has been said of its bad effects upon sheep, but these have arisen either because an inferior quality of silage was fed or on account of carelessness on the part of the feeder in not feeding it properly.

A good quality of silage is extremely palatable and can be fed to all classes of sheep with good results. It must be borne in mind, however, that silage which is either very sour, moldy, or frozen should not be fed.

The amount of silage reported in feeding trials varies from 1 to 5 pounds per head per day. The amount to feed depends upon the class of sheep and the character of the other feeds comprising the ration. As a general rule from 2 to 4 pounds per head per day is considered as much as should be fed.

Lamb feeders have found silage a very satisfactory feed, and the amount fed ranges from 1 to 3 pounds per day. Where lambs are on full feed of grain, such as corn, and are receiving a fair allowance of hay, they will, as a rule, only consume from 1 to 2 pounds per head per day.

In feeding breeding ewes before lambing a daily allowance of from 2 to 3 pounds should be considered a maximum quantity. After lambing the amount can be slightly increased.

In feeding silage or any other succulent feeds it must be borne in mind that the value of such feeds to a large extent is to act as an appetizer and to keep the digestive system in good condition. Under ordinary conditions where silage is fed it should not constitute more than one-half of the entire ration, and it should be fed with other feeds that will properly balance the ration for the purpose intended.

